

March 1981

DCIEM Technical Communication No. 81-C-14

Halon 1301 Fire Suppression System
Evaluation in the Cougar Fire Support Vehicle
and the Grizzly Armoured Personnel Carrier

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ABSTRACT

A study was carried out to determine the concentration of Halon 1301 fire suppressing agent obtained within the crew compartment and engine compartment of the Cougar fire support vehicle and the Grizzly armoured personnel carrier, upon activation of their fire suppression systems. Measurements showed that the highest concentrations of agent obtained within the crew compartment and engine compartment of the Cougar were 3.2% v/v and 15.8% v/v, respectively. Similarly, the highest concentrations achieved in the crew compartment and engine compartment of the Grizzly were 6.7% v/v and 9.8% v/v, respectively. The concentrations of agent, which were measured in the crew compartments would not create an occupational hazard to occupants for up to 15 minutes of exposure; however, the concentration achieved within the crew compartment of the Cougar may be ineffective for fire suppression.

INTRODUCTION

Halon 1301, bromotrifluoromethane, CBrF_3 , is an effective fire extinguishing agent that can be used on many classes of fires. It has been demonstrated that efficient fire suppression is achieved using concentrations of 4% to 7% v/v Halon 1301 in air (1).

This study was carried out to determine the concentration of Halon 1301 produced from the discharge of the fire suppression systems in both the Grizzly and Cougar vehicles. Concentrations of the agent were measured to determine if they reached the required level for extinguishing fires and if such a concentration would constitute a hazard to occupants of the vehicle. As far as safety of the occupants is concerned, the conclusions of this study are valid only for accidental or practice activation of the system since the combined effects of the extinguishing agents and toxic combustion products have not been considered.

PROCEDURES

These trials were conducted during 17 - 18 February, 1981, at the Land Engineering Test Establishment (LETE) Orleans, Ontario, on the Cougar fire support vehicle and the Grizzly armoured personnel carrier.

The fire extinguishing system in these vehicles is the same and consists of one Halon 1301 cylinder designed to discharge 4.5 kg of agent through four nozzles in the crew compartment, one nozzle in the driver location and three nozzles in the engine compartment. The system may be activated from the interior by a switch near the driver or from outside by an externally-mounted switch.

Two separate trials, each carried out in duplicate, were conducted to determine the concentration of Halon 1301 released into the engine and crew compartments of both vehicles. In these trials the fire suppression system was activated by means of the externally-mounted switch. During the monitoring period, each of the vehicles was in the completely closed-down configuration with all hatches, ports and doors closed and none of the ventilation systems or the engine in operation.

The procedure used was to monitor the interior background atmospheric air prior to actual release of the Halon 1301, followed by measurement of concentration build-up from activation of the system until equilibrium was reached and the concentrations started to fall. The crew compartments and engine compartments were examined in separate experiments.

The weight of Halon 1301 expended in each experiment was

determined by the pre- and post-weighing of the Halon 1301 cylinders employed.

Sampling Procedures

Following each release of Halon 1301 into a vehicle crew or engine compartment, continuous sampling was carried out by means of a Dupont Constant Flow Pump connected to a 4-metre, 6.4mm OD polyethylene sampling line either inserted through a floor drain-plug in the vehicle crew compartment or located in the engine compartment. During the crew compartment trials, the inlet of the sampling line was centrally located within the crew compartment. For the engine compartment monitoring, the inlet of the sample line was located centrally, just above the top of the engine.

The atmospheric samples thus obtained were introduced onto the column of a Carle 9700 gas chromatograph equipped with a Flame Ionization Detector, by means of a 50 ul gas sampling valve. In this fashion, it was possible to introduce 50 ul samples into the gas chromatograph at 15-second intervals in a continuous fashion. In each experiment, sampling was carried out until a peak concentration was reached. This was determined when there was no further rise in the concentration measured following four consecutive 15-second interval samples.

In addition to the determination of the Halon 1301 concentration within the crew compartments of either vehicle, atmospheric oxygen was also measured. For this purpose, a second sample line, similar and parallel to that used to measure the Halon, was connected to a Dupont constant flow pump. The outlet of this sampling line was then connected to the sensor of a Model OM-300 oxygen monitor (Biomarine Industries, Malvern, Pa, U.S.A.).

Calibration

The calibration of the gas chromatograph used for the analysis of the Halon was carried out utilizing three standard concentrations of Halon 1301 with the subsequent calculation of a three point calibration line. The standards employed were commercially prepared and analyzed to contain 5.5%, 10.7% and 15.8% v/v Halon 1301 in air (Matheson Canada Ltd). These standards were used to calibrate the instrument on site prior to and immediately following each trial.

The oxygen monitor was calibrated using nitrogen as a nil-response gas and the concentration of oxygen in the ambient atmosphere was nominally assigned a concentration of 20.95% v/v. The frequency of calibration was similar to that employed for the Halon analyzing gas chromatograph.

RESULTS AND DISCUSSION

The maximum concentrations of Halon 1301 measured and the concentration of oxygen present, plus the amount of Halon released, as summarized in Table I.

TABLE I
Summary of Experimental Results

Vehicle	Compartment	Halon 1301 Released (kg)	Maximum Concentration of Halon 1301(v/v%)	Minimum Concentration of Oxygen (v/v%)
Cougar	Crew	4.54	2.9	20.3
		4.88	3.2	
	Engine	4.42	14.8	
		4.76	15.8	
Grizzly	Crew	4.76	6.4	19.8
		4.88	6.7	
	Engine	4.88	9.2	
		4.88	9.8	

Undecomposed Halon 1301 has a threshold for central nervous system effects in humans of 7 % v/v for an exposure of approximately five-minutes duration. At concentrations of 7 to 10 %, effects such as dizziness, impaired coordination and reduced mental activity are produced if the exposure lasts for several minutes; however, the effects are non-incapacitating if the time of exposure to these concentrations is less than one minute. At concentrations above 10 %, the toxic effects increase in intensity and may become incapacitating following exposures longer than one minute (2). This information is summarized in Table II in terms of exposure limits.

TABLE II
Halon 1301 Exposure Limits (3)

HALON 1301 CONCENTRATION	MAXIMUM EXPOSURE TIME
0.1 % AND BELOW	8 HOURS/DAY, 5 DAYS/WEEK
7 % AND BELOW	15 MINUTES
7-10 %	1 MINUTE
10-15 %	30 SECONDS
ABOVE 15%	PREVENT EXPOSURE

From the results obtained, it is apparent that the maximum concentration of agent generated in the crew compartments of both vehicles was below that considered to be hazardous to human health for exposure times of 15 minutes or less (3). The values reported for oxygen content of 20.3% for the Cougar and 19.8% for the Grizzly, though slightly below the normal percentages found in the atmosphere, are well above the 17% for safe entry into what is considered a "confined space" (4). Of greater significance, however, was the finding that the concentration of Halon 1301 measured within the crew compartment of the Cougar was below the 4 to 7% range recommended as necessary for efficient fire suppression (1).

The results obtained in this study indicate that the distribution of the fire extinguishing agent between the crew and engine compartments of the two vehicles tested was grossly different. As the internal volume of both of these vehicles is very similar, it is apparent that the Halon delivered to the crew compartment of the Cougar was approximately one-half that of the Grizzly. The amount of agent released into these two compartments from the single cylinder of Halon is related to the distribution of nozzles, i.e., five nozzles in the crew compartment vs three in the engine compartment. As both the vehicles tested had this same system of delivery, and the same amount of agent released, it is apparent that the low levels of Halon found in the Cougar can be related to either improper functioning of the nozzles or incorrect nozzle installation.

CONCLUSION

Based on the findings of this study on the concentration of both Halon 1301 and oxygen, in the two vehicles tested, no hazard exists to the crew members for up to 15 minutes of exposure when the Halon 1301 Fire Extinguisher System is activated. It was found, however, that the amount of agent delivered to the crew compartment of the Cougar may be insufficient for fire suppression.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the technical assistance provided by Sgt. E. Paulsen and Cpls. L. O'Neill and P. Yergeau in performing this survey and also WO R. Arbuckle of the staff of LETE, who made this study possible.

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